

Virginia's Water Resources

Water is vital to Virginia's well-being, as it is to communities across the globe. Water supports virtually every human endeavor—from farming and forestry to the generation of electric power and all types of manufacturing processes.

Water sustains human “habitat” as it does for the millions of plants and animals that share the planet with us. Here in our little corner of the world, fresh water use currently totals more than 5,467 million gallons per day (mgd), or approximately 826 gallons daily for each Virginia resident.

Where is Virginia's Water?

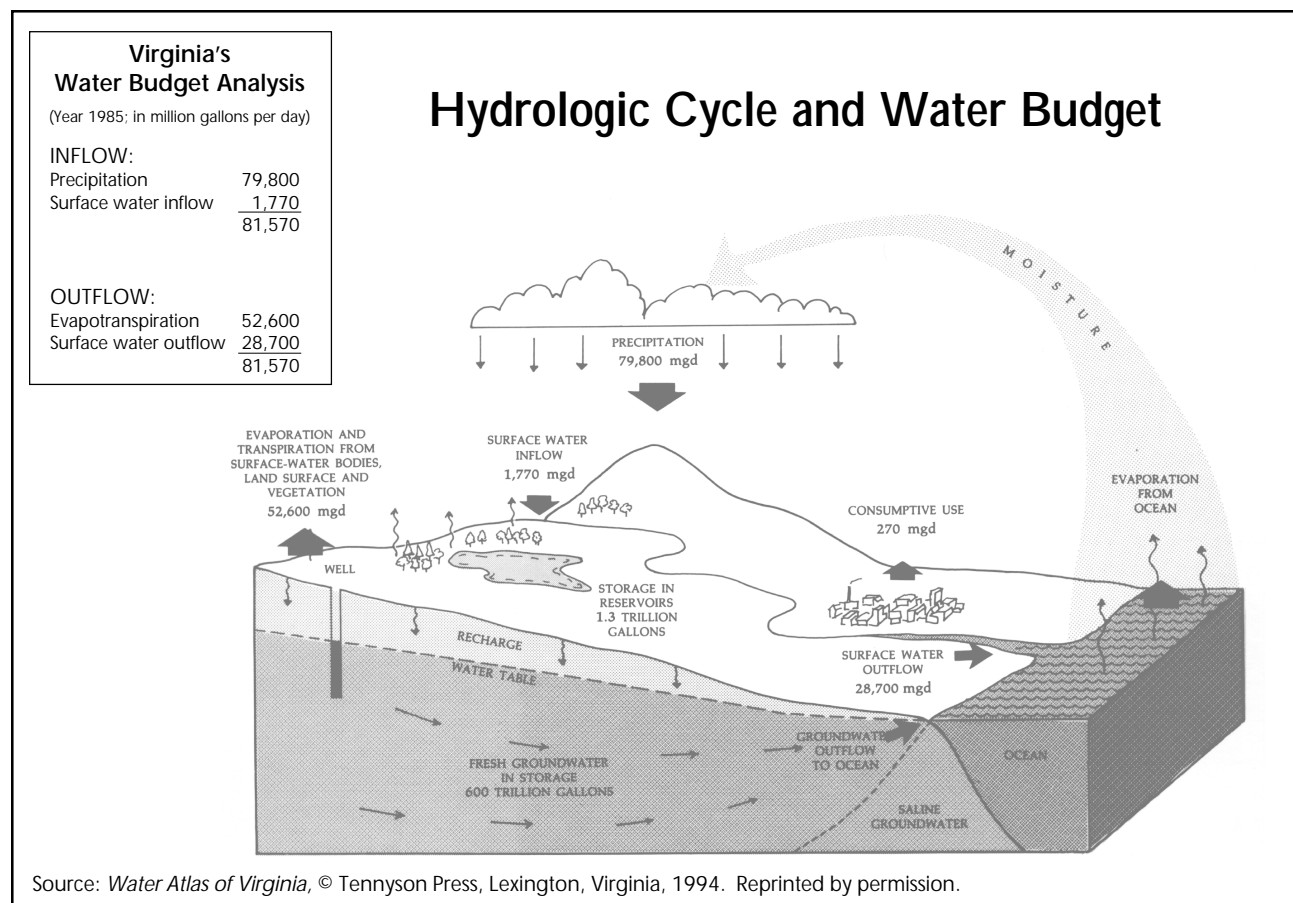
The state's average annual rainfall is 42 inches but, in truth, it ranges from 35 to 55 inches (based on 30-year records). In Virginia, rainfall is distributed evenly throughout the year without distinct wet and dry periods. This abundance — approximately 79,800 million gallons per day — supplies Virginia's surface and ground water. Precipitation in the form of rain, snow, or ice falls to the earth and replenishes surface wa-

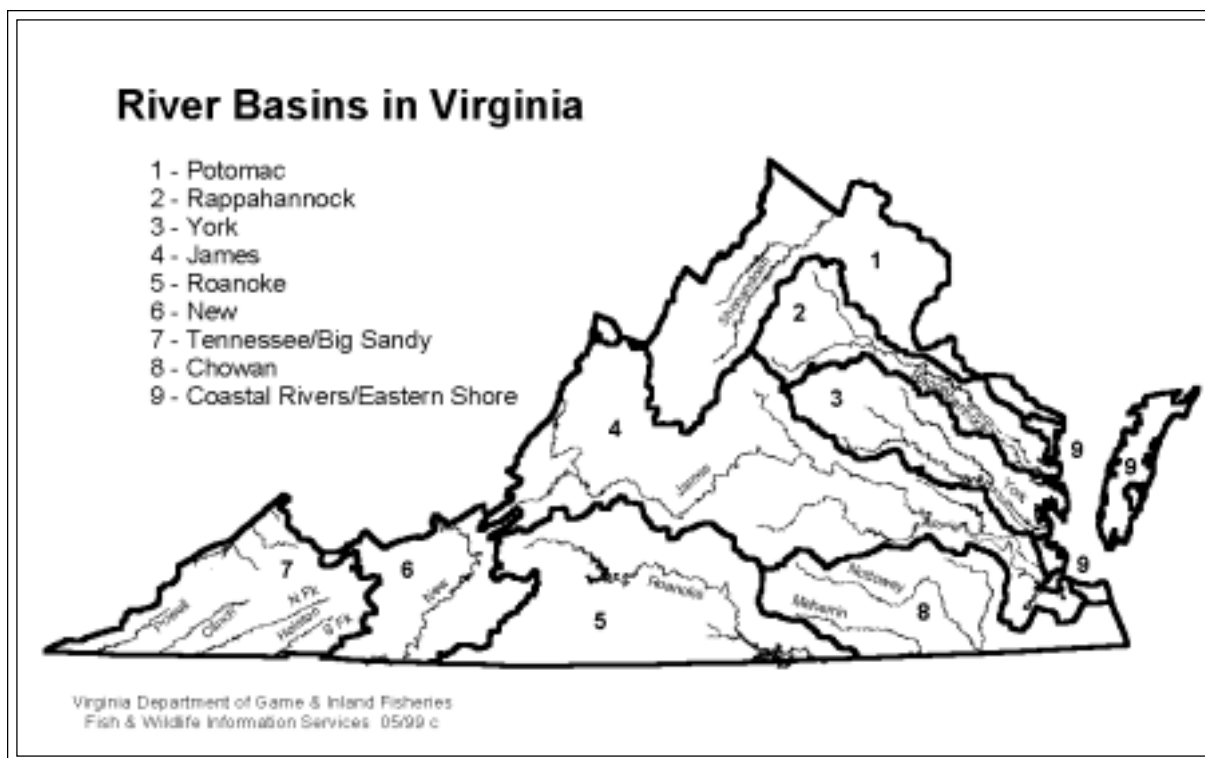
ters. Some of the precipitation filters into the soil and continues down through cracks and crevices to replenish ground water, a zone where all pore spaces become saturated.

River Basins

Virginia has nine major river basins whose natural, recreational, commercial, and cultural resources combine to make the Commonwealth a rich blend of colors and contours. While most of the state drains into the Chesapeake Bay, water from the westernmost basins ends up in the Gulf of Mexico. Rivers in the Roanoke and Chowan basins, by contrast, empty directly into the Atlantic Ocean.

It was along the banks of the wide, placid James River that English colonists settled in the early 1600s, establishing Tidewater Virginia as the “Cradle of the Republic.” The James and her sister rivers draining to the Chesapeake Bay — the York, Rappahannock, and Potomac rivers — drain nearly two-thirds of Virginia's land mass.





The Commonwealth's western rivers—the ancient New River and the Tennessee-Big Sandy—course through rugged mountain valleys where generations of Virginia farmers, miners, trout fishermen, and white-water rafters have capitalized on their spirit. And the Roanoke and Chowan rivers meander through Virginia's Southside, sustaining peanut and tobacco farms, textile industries, and lakeside vacationers.

Rivers carry enormous amounts of water, especially during floods when peak flows can reach 40 to 80 times their average volumes. During such events, rivers also transport enormous amounts of sediment and pollution. And rivers are known to unleash tremendous force upon human resources during such storm events.

It wasn't that long ago, in June 1972, that Hurricane Agnes deposited more than 6 inches of rain

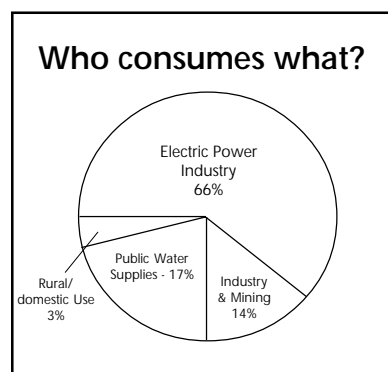
over many parts of Virginia (a record amount in one day for Lynchburg and the National Airport in Washington, DC). The soil was already saturated and when heavy rains hit, the result was rapid

runoff and disastrous flooding. Water levels in the James River in Richmond reached a peak of 36.5 feet, the highest recorded level in more than 200 years. Average stream flow at this station is 6,796 cubic feet per second (cfs) and, during Agnes, it peaked at 313,000 cfs. Water supply, sewage treatment, and electric and gas plants were flooded. Throughout the state, 1,400 homes, roads, and bridges were destroyed and 13 people killed, amounting to 325 million dollars in damage.

Protecting Water Resources

Protecting our water is the responsibility of all Virginians, including state government. Virginia was among the first state in the nation to embrace this responsibility and in 1946 enacted the Virginia Water Control Law to combat water pollution (two years before the adoption of the first Federal Water Pollution Control Act by Congress). Over the past 30 years, resource managers have made great strides to address water-related concerns. One concern is adequate future supplies for shared use by consumers, farmers, industries, and recreationists. The goal sounds simple enough but may prove our most challenging: to provide the right quantity of satisfactory quality water where and when it is needed.

For example, power plants supplying electricity and factories supplying goods use *vast amounts* of water.



Already, surface and ground water resources are limited in areas where demand is greatest. The result can create conflicts among local governments, who are not neatly aligned along river basin lines. In some regions of the state where conflicts have become acute (such as the Eastern Shore), designated Ground Water Management Areas have been established, and large water withdrawals (>10,000 gpd) require special permits.

Good water quality is another concern — complex in its dimensions. Practically everything we do in our day-to-day lives has an impact on water quality. Whenever we take a shower, wash a dish, or flush a toilet, the wastewater likely passes through a sewage treatment plant that eventually discharges into a local river. All of these actions become “drops in the stream” of what we call “point source” pollution, or pollution traceable to a discrete point. Mining, forestry, farming, and construction are all examples of soil-disturbing activities that can lead to erosion and, ultimately, soil running off the land into nearby water bodies. All have the capacity to add nutrients, sediments, toxics, minerals, or acids to lakes and streams. This type of pollution is called “nonpoint source” pollution, meaning it emanates from sources difficult to pinpoint.

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The Department of Environmental Quality (DEQ) has issued more than 3,000 discharge permits to businesses, municipalities, and individual homeowners.

Surface water is the kind we can easily see—streams, lakes and reservoirs, springs, and wetlands.

- † **Rivers:** 49,000 miles of streams in 9 major river basins
- † **Lakes:** 450 public and private covering 322,000 acres
- † **Springs:** 1,600 (100 of them yield > 450 gallons per minute)
- † **Wetlands:** 1,000,000 acres, decreased from 1.8 million acres in 1780

Ground water is found beneath the soil mantle in rock fractures and sediment formations. Large units that yield water to wells are called aquifers. The annual recharge to the groundwater system from precipitation ranges from 8 inches in western Virginia to 10 inches in the Coastal Plain. About 2 million Virginians, or 34%, depend entirely on wells for drinking water.

The documents set pollution limits that specify how clean a permit holder’s wastewater must be before it is discharged into a stream or river. The vast majority of permit holders consistently meet their permit limits, ensuring that users downstream (people, plants, and animals) receive the water in good condition. In addition, Virginia has spent nearly half a billion dollars over the past decade to build or upgrade its sewage treatment plants across the state. The result has been a dramatic reduction in the amount of raw or partially treated sewage going into state waters.

Today’s Troublemakers

- u **Sediments** - from soil erosion
- u **Urban and suburban stormwater flows** - from storm events
- u **Phosphates and nitrates** - from agricultural sources
- u **Improperly treated sewage** - from overflows during storm events, or from failing septic systems
- u **Industrial wastes** such as acids, oils, and grease - from factories and other industrial facilities
- u **Acids and leachates** - from abandoned mines and dumps
- u **Encroaching salt water** - from the ocean into groundwater supplies
- u **Herbicides and pesticides** - from water and sediments running off the land

In 1997 the Virginia General Assembly passed the Water Improvement Act to help fund innovative technologies and programs to further improve water quality. Evidence is mounting that we’re making progress. The most recent statewide water quality assessment (April 1996) showed that most Virginia waterways — 93.7 percent of all streams monitored — are in good shape and meet or exceed water quality standards. Bald eagles, ospreys, and pelicans have returned to fish Virginia waters. In the Chesapeake Bay, striped bass have made a dramatic comeback, underwater grasses have increased 60 percent since 1984, and phosphorus levels have been reduced 19 percent since 1985. The amount of toxic chemicals released by industries into the Bay watershed has declined 55 percent since 1988.

Challenges remain, however. The most serious threats to water quality in Virginia today involve nonpoint sources of pollution — storm runoff from

farms, streets, parking lots, lawns, construction sites and other developed lands. Indeed, the April 1996 assessment found that the vast majority (83 percent) of water pollution problems in the Commonwealth are caused by such elusive sources.

Runoff often carries excess fertilizers, manures, toxic chemicals, pathogens and sediments into rivers and streams.

Here are some suggestions on how to “lighten your footsteps” upon the land:

- t Farmers, foresters, and contractors engaged in land-altering activities can take sediment and erosion control measures;
- t Localities can implement storm water controls and steer development away from sensitive natural areas;
- t Homeowners can use less toxics in the home and garden—specifically, cleansers and pesticides;
- t Homeowners and developers can reduce paved (impervious) surfaces and the use of fertilizers; and
- t Everyone can recycle motor oil and dispose of hazardous substances safely by following label instructions.

DEQ and other state agencies are working with local governments, industries, volunteer groups, and citizens to address these and other water pollution issues. Today DEQ maintains a network of more than 1,100 monitoring stations that regularly sample and analyze streams, rivers, lakes, and bays across the state. DEQ monitors 17,000 miles of free-flowing streams. The agency also regularly surveys stream life — the aquatic organisms living in the water — and takes samples of bottom sediments and fish tissues for

toxic analysis. Together with data from other state agencies and active citizen monitoring groups, DEQ has a comprehensive database of water quality information, the basis for making continued improvements and informed decisions.

Interested in a Water Quality Project?

Students can participate in a number of projects.

Here are a few ideas:

- ◆ Stream and Beach Clean-ups - involve riverbank or beach trash collection;
- ◆ Tree Plantings - involve planting trees in the “riparian” zone, or streambank corridor;
- ◆ SAV Counts and Plantings - involve restoration of underwater vegetation; and
- ◆ Water Quality Monitoring - involves a class to become trained in biological or chemical monitoring.

Additional Resources

Web Sites:

u Virginia Department of Environmental Quality;
www.deq.state.va.us

u Va. Department of Conservation & Recreation;
www.dcr.state.va.us

Other Resources:

u van der Leeden, Fritz. 1993. *Water Atlas of Virginia, Basic Facts About Virginia's Water Resources*. Lexington, VA: Tennyson Press, ISBN: 0-9638711-0-2. A collection of 46 maps depicting various aspects of Virginia's water resources accompanied by an explanation of key features; call (540) 463-2599.

u Citizens for Water Quality; a state-wide consortium of people interested in preserving and enhancing Virginia's water resources; contact the state water quality coordinator at DEQ, (804) 698-4026.

Fundamental Learnings Related to Water Resources

℞ All life processes, from the level of a cell to that of an ecosystem, require water. Both the quantity and quality of water are important. Habitats with abundant plants and animals are areas with clean water in good supply.

℞ Water is found in the atmosphere, on the surface, and underground. The water cycle is central to life on Earth and connects Earth systems.

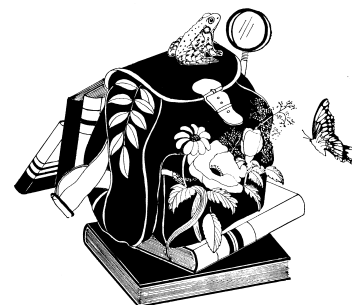
℞ Water is a natural resource that must be managed. The amount of available freshwater is limited (99% of the Earth's water is saline) and must support multiple users. Clean, sustainable water supplies are vital. When supplies fail to meet demands, conflicts arise.

℞ Aquatic environments are subject to much use and abuse by people. Water pollution occurs when chemicals, nutrients, or sediments are placed into water faster than they can be removed by natural processes. Water pollution can often be traced to runoff in the watershed.

℞ While water is useful as a cleaning agent (“the universal solvent”) and as a means for disposing of soluble waste, the capacity for water to dilute pollutants is limited.

What's Your Watershed Address?

Easy ways to demonstrate how water flows through a watershed



Watershed Background

A watershed, also called a drainage basin, is a geographic area in which water, sediments, dissolved minerals and other pollutants, including trash, drain into a common body of water. While we all reside in one, many of us do not even know its name. There are nine distinct watersheds or river basins that lie within the state of Virginia. They are from south-west to north-east: The Tennessee-Big Sandy, the New, the Roanoke, the Chowan, the James, the Potomac-Shenandoah, the Rappahannock and the York. The James River is the largest watershed. It includes all or parts of 39 counties and 18 cities and drains one-fourth of the state's land area into the Chesapeake Bay.

Discuss the concept of a watershed and how water travels over and through the land. Students may wonder where water goes after it flows down the street during a heavy rainstorm. Make the connection between people living in the watershed and the impacts that they have upon water quality; specifically, non-point source pollution. Provide some examples of how the actions and behaviors of individuals (including pets and their owners) and businesses in your area affect the water quality of your local watershed and the body of water into which the watershed drains, such as the Chesapeake Bay. Don't forget to include sewage treatment plants, homes, commercial developments, and factories.

Discuss the speed at which water flows and how moving water changes the land. You can refer to the branches on a tree, or the veins in a leaf, or the human nervous system to describe how bodies of water "branch out" with smaller branches analogous to streams branching into larger ones, such as rivers, and so forth. Explain that watersheds can be open or closed depending on where the water drains. In closed systems, there is no outlet for the water, so it leaves the system naturally by evaporation or by seeping into the ground (becoming groundwater). In open watershed systems, such as those found in Virginia, water eventually flows into outlet rivers or a bay and, ultimately, the sea.

Activities

There are numerous ways that students can build a model of a watershed, ranging from individually constructed models made of paper to larger scale models created by using a shower curtain or tarp. Here are some easy ways to demonstrate topography and the action of water flowing through a watershed:

1) *Students use crumpled paper to create a miniature watershed model:* Crumple a piece of paper into a tight ball. Gently open up the paper, but don't flatten

Grade Levels: 3-6

Science SOLs:
3.9, 4.8, 6.11

Materials:

- r A map of your local area showing streams (topographic is good but not essential)
- r Paper and markers
- r Paint trays (1-2)
- r Aluminum foil, or a white shower curtain
- r Rocks, or blocks
- r A powdered "pollutant," such as cinnamon or Kool Aid or cocoa
- r Sponges and small toys

Objectives:

Students will be able to predict where water will flow in watersheds, describe drainage patterns in watersheds, and identify sources of pollution.

Vocabulary Words:

erosion
groundwater
hydrologic cycle
nonpoint source pollution
nutrients
pollutants
runoff
water pollution
watershed

it out completely. The highest points on the foil or shower curtain represent the mountain tops and the lowest wrinkles, the valleys. Choose one color of water soluble marker and use it to mark the highest points on the map. These points are the mountain ridge lines. Choose a second color and mark the places where different bodies of water might be: creeks, rivers, and lakes. With a third color, mark four or five places to represent human settlements: housing tracts, factories, shopping centers, office buildings, schools, etc. Try sprinkling a powdered material, such as cinnamon, red pepper, or cocoa powder, to demonstrate how pollutants flow through the watershed. Use spray bottles to lightly spray the topographic watershed maps. The spray represents water falling into the watershed.



Drainage Divide

2) *Or, you can use a paint tray to create a slightly larger model:* Place small rocks or other objects on the tray, and cover the tray with aluminum foil or a white garbage bag. Use spray bottles to represent rain. Sprinkle powdered materials such as cinnamon, Kool Aid, or cocoa powder to represent how pollutants flow through the watershed. Place sponges at the bottom of the watershed to represent wetlands that help clean the water. To show how wetlands help to hold and clean water, you could conduct a test (either using two paint trays or one paint tray with two different scenarios) to see which watershed drains more quickly and how much water reaches the end of the tray. In either case, measure the water before you spray it into the watershed and again, afterwards. You could also time the contest.

3) *Or, create a large watershed using a white vinyl shower curtain:* Place some objects such as buckets and boxes, or even a chair (lying on its side), under the shower curtain or plastic tarp to represent the mountains and follow the steps listed above for the paint tray model. This scenario is best done outdoors! You can also add some small toys to represent land uses (cows and tractors to represent farms, cars and people or houses for residential areas, a bulldozer for development; use your imagination).

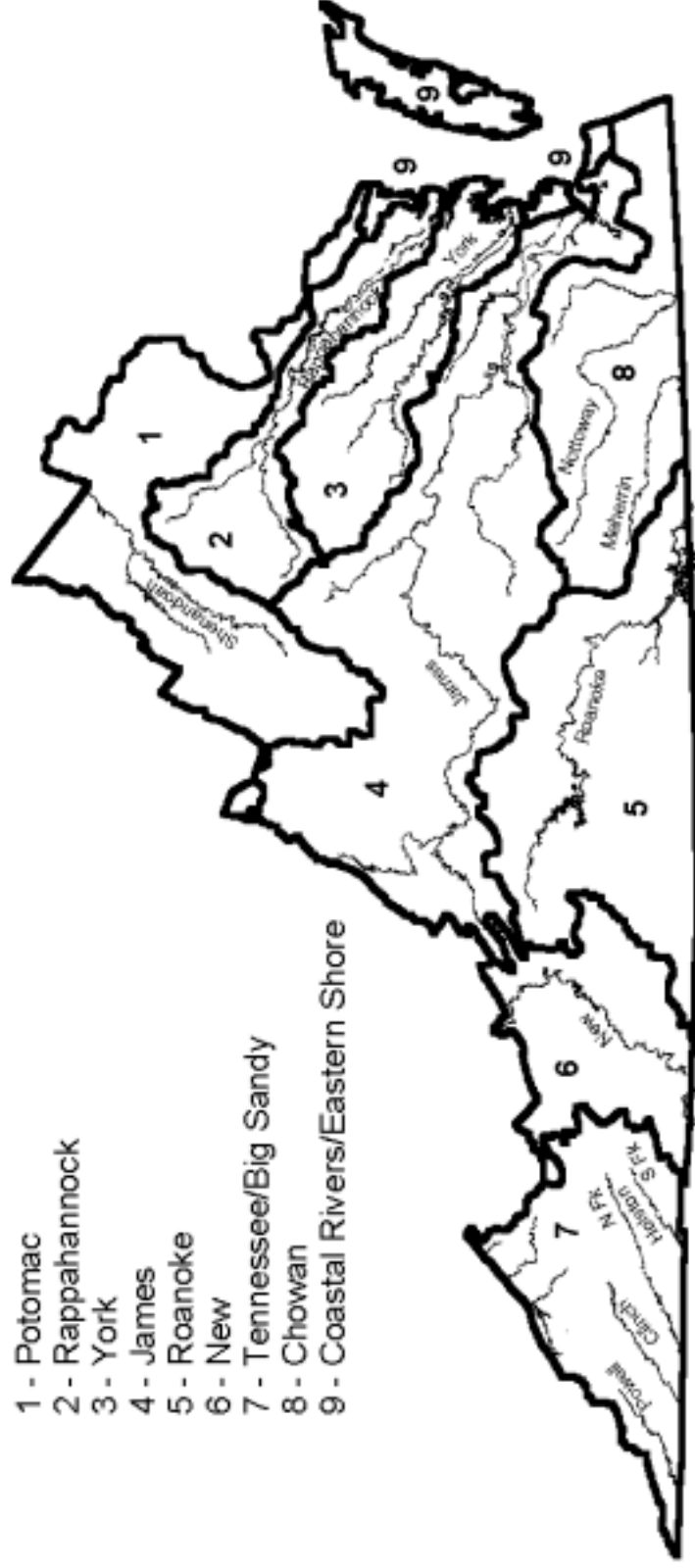
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Discussion

- 1) Discuss how the water travels through the system.
 - u What changes do you observe in the "paper" watershed maps?
 - u Where does erosion occur?
 - u What happens to human settlements -- are any buildings in the way of a raging river or crumbling hillside?
 - u How does the flow of water through the watershed affect choices for building sites?
 - u What happens to the "pollutants," -- where do they end up?
 - u What factors may lead to increased pollutants such as run-off from sediments, industrial wastes, phosphates and nitrates from agricultural sources, sewage, and residential runoff including pesticides.
 - u What are some ways to reduce or prevent these "non-point" source pollutants?
- 2) Use the accompanying map to identify the river basin or "Watershed Address" of your community.

River Basins in Virginia

- 1 - Potomac
- 2 - Rappahannock
- 3 - York
- 4 - James
- 5 - Roanoke
- 6 - New
- 7 - Tennessee/Big Sandy
- 8 - Chowan
- 9 - Coastal Rivers/Eastern Shore



Virginia Department of Game & Inland Fisheries
Fish & Wildlife Information Services 05/99 c

Virginia's Hydrologic Cycle and Water Budget

Water Budget Analysis

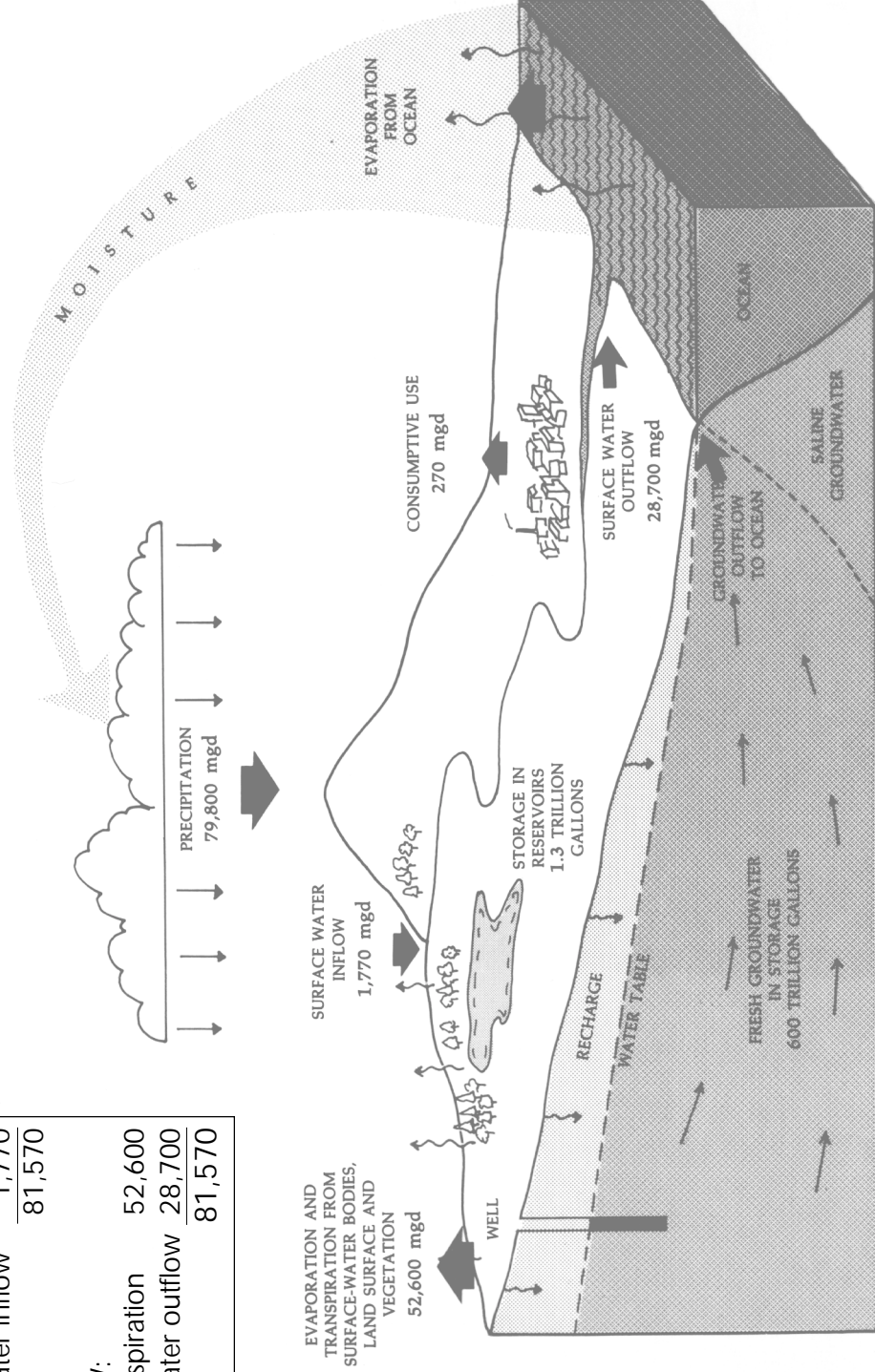
(Year 1985; in million gallons per day)

INFLOW:

Precipitation	79,800
Surface water inflow	1,770
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	81,570

OUTFLOW:

Evapotranspiration	52,600
Surface water outflow	28,700
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	81,570



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